Example 1 - Greenhouse Gas PSD Applicability
Example Determination Calculations

Natural Gas Compressor Stations

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Example Scenario 1: New Natural Gas Compressor Station

STEP #1 – Identify Emitting Units

- One (1) 660 Brake Horsepower (hp) Compressor Engine
- One (1) Reboiler

(Note: Other emitting units typically exist at a natural gas compressor station but only these emitting units are included for this example.)

STEP #2 – Calculate Potential to Emit (PTE)

For this example, let's assume the facility PTE for each criteria pollutant is as follows:

PM_{10} = 0.26 tons per year (tpy)
CO = 9.00 tpy
NO_x = 70.49 tpy
SO_x = 0.01 tpy
VOC = 28.07 tpy

STEP #3 – Determine PSD Applicability for Criteria Pollutants

Based on the calculations above, the facility would not be subject to PSD for these criteria pollutants. The facility is not a listed source and emissions of each criteria pollutant are less than 250 tpy.

STEP #4 – Determine PSD Applicability for GHGs and Calculate PTE for GHGs

In this step, calculate the potential emissions for the applicable GHGs. GHGs listed in the final rule include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). (Note: Some of these GHGs have a higher global warming potential (GWP) than the others so they are expressed in CO_2 equivalents (CO_2e) in order to help standardize the evaluation of GHGs and determine if a facility is covered by a permitting program.)

For this hypothetical example, however, we will focus on the stationary combustion sources (e.g., as the natural gas compressor engine and reboiler) in which CO_2, CH_4, and N_2O are the GHGs that are formed during the combustion process.

In general, there two basic approaches that may be used to estimate greenhouse gases from a combustion source.

1.) Direct measurement (e.g., CEMS).

2.) Calculation based method.
    a.) Fuel analysis approach.
    b.) Generalized approach (e.g., emission factors).

For this example scenario, let's focus on a generalized approach using emission factors for stationary combustion sources.

Generalized Approach

Example Greenhouse Gas Emission Factors for Natural Gas Combustion:

- 116.87 lb/MMBtu for CO_2
- 0.011014 lb/MMBtu for CH_4
- 0.000022 lb/MMBtu for N_2O

(Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks, April 2008. U.S. EPA.)
(Note: Emission factors can likely be obtained from a variety of sources so make sure you reference and/or justify them, as appropriate.)

Global Warming Potentials:

- Carbon dioxide (CO_2) = 1
- Methane (CH_4) = 21
- Nitrous oxide (N_2O) = 310

(Source: Table A-1, Title 40, Part 98, Subpart A)

Miscellaneous Assumptions/Information:

1. Natural Gas Compressor Engines Fuel Consumption = 8500 Btu/hp-hr @ Maximum Design Capacity
2. Reboilers Fuel Consumption = 256 MBtu/hr @ Maximum Design Capacity
3. Natural Gas Heat Value = 1020 Btu/scf

Calculations:

The GHG emissions calculations will be completed by calculating the CO_2 emissions and converting the CH_4 and N_2O to their CO_2e and summing the CO_2e for each GHG.

Emitting Unit #1: Natural Gas Compressor Engines

Fuel Consumption:
660-hp * 8500 Btu/hp-hr * 1/1020 Btu/scf * 1 Mscf/1000 scf = 5.55 Mscf/hr = 132 Mscf/day = 48,180 Mscf/yr =48.18 MMscf/yr

Heat Produced:
48.18 MMscf/yr * 1020 Btu/scf * 1,000,000 scf/1MMscf = 49,143,600,000 Btu/yr = 49,144 MMBtu/yr

Carbon Dioxide (CO_2):
116.87 lb/MMBtu * 49,144 MMBtu/yr * 1 ton/2000 lb = 2,872 tons/yr of CO_2

Methane (CH_4):
0.011014 lb/MMBtu * 49,144 MMBtu/yr * 1 ton/2000 lb = 0.27 tons/yr CH_4

Nitrous Oxide (N_2O):
0.000022 lb/MMBtu * 49,144 MMBtu/yr *1 ton/2000 lb = 0.0005 tons/yr N_2O

Total GHG Emissions for Compressor Engines on a Mass Basis:

2,872 tons/yr of CO_2+ 0.27 tons/yr CH_4 + 0.0005 tons/yr N_2O = **2872.3 tons/yr of GHGs** on a mass basis

Total Emissions of CO_2e are as follows:

Carbon Dioxide (CO_2):
116.87 lb/MMBtu * 49,144 MMBtu/yr * 1 ton/2000 lb = 2,872 tons/yr of CO_2e

Methane (CO_2e):
CH_4 in tons/yr * GWP for CH_4 = CO_2e for CH_4
0.27 tons/yr CH_4 * 21 = 5.67 tons/yr CO_2e

Nitrous Oxide (CO_2e):
N_2O in tons/yr * GWP for N_2O = CO_2e for N_2O
0.0005 tons/yr N_2O * 310 = 0.16 tons/yr CO_2e

Sum the Total CO_2e Emissions:

CO_2e emissions for the compressor engine = 2, 872 tons/yr CO_2 + 5.67 tons/yr CH_4 (CO_2e) + 0.16 tons/yr N_2O (CO_2e) = **2,879 tons/yr CO_2e**

Emitting Unit #2: Reboiler

Fuel Consumption/Heat Produced:
Reboiler Fuel Consumption = 256 MBtu/hr @ Maximum Design Capacity
256 MBtu/hr = 6,144 MBtu/day = 2,242,560 MBtu/yr = 2,242.56 MMBtu/yr

Carbon Dioxide (CO_2):
116.87 lb/MMBtu * 2,242.56 MMBtu/yr * 1 ton/2000 lb = 131.04 tons/yr of CO_2

Methane (CH_4):
0.011014 lb/MMBtu * 2,242.56 MMBtu/yr * 1 ton/2000 lb = 0.012 tons/yr CH4

Nitrous Oxide (N_2O):
0.000022 lb/MMBtu * 2,242.56 MMBtu/yr *1 ton/2000 lb = 0.000025 tons/yr N_2O

Total GHG Emissions for Reboilers on a Mass Basis:

131.04 tons/yr of CO_2+ 0.012 tons/yr CH_4 + 0.000025 tons/yr N_2O = **131.05 tons/yr** of GHGs on a mass basis for the reboiler

Total Emissions of CO_2e are as follows:
Carbon Dioxide (CO_2e):
116.87 lb/MMBtu * 2,242.56 MMBtu/yr * 1 ton/2000 lb = 131.04 tons/yr of CO_2e

Methane (CO_2e):
CH_4 in tons/yr * GWP for CH_4 = CO_2e for CH_4
0.012 tons/yr CH_4 * 21 = 0.25 tons/yr CO_2e

Nitrous Oxide (CO_2e):
N_2O in tons/yr * GWP for N_2O = CO_2e for N_2O
0.000025 tons/yr N_2O * 310 = 0.0077 tons/yr CO_2e

Sum the Total CO_2e Emissions for the Reboilers:

131.04 tons/yr CO_2e + 0.25 tons/yr CH_4 (CO_2e) + 0.0077 tons/yr N_2O (CO_2e) = **131.30 tons/yr CO_2e**

Sum the Total CO_2e Emissions for the Compressor Engine and Reboiler:

2,879 tons/yr + 131.30 tons/yr = 3,010 tons/yr CO_2e

Applicability PSD Analysis Overview:

Question #1: Does this permit action result in an increase of any criteria pollutant above PSD threshold levels?

No, the potential NO_x emissions are less than the 250 tpy threshold so a PSD analysis for NO_x would not be required.

Question #2: Does this permit action have GHG emissions above the PSD threshold on a mass basis?

Yes, the potential GHG emissions were approximately 3,003 tpy on a mass basis.

Question #3: Does this permit action result in CO_2e emissions above the PSD threshold?

No, the CO_2e emissions (3,010 tpy) were less than the 75,000 tpy CO_2e threshold.

A PSD review would NOT be required for any criteria pollutant because all are less than 250 tpy threshold for a non-listed source. The answer to Questions #2 and #3 must both be "Yes" for GHGs to undergo a PSD review for GHGs. Because the total CO_2e for the new facility was less than the 75,000 tpy threshold for GHGs, no PSD review would be required for GHGs.

Title V Applicability Analysis/Overview:

Question #1: Are the potential emissions of any criteria pollutant greater than 100 tons per year?

No.

Question #2: Are the potential emissions of GHGs greater than 100 tons per year?

Yes.

Question #3: Are the potential emissions as CO_2e greater than 100,000 tons per year?

No.

If the answer to Questions #1, #2, and #3 is "Yes", a Title V permit action to address GHGs are described in the following scenarios.

- A department decision occurring before January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after January 2, 2011, must address GHGs in the Title V permit.
- A department decision occurring after July 1, 2011, must address GHGs in the Title V permit.

If the answer to Questions #2 and #3 is "Yes", a Title V permit action to address GHGs are shown as follows:

- A department decision occurring before January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after July 1, 2011, would require GHGs to be addressed in the Title V permit.